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Description

Injectors and hydrokinetic amplifiers, such as shown in US-A-4,569,635, are constant flow devices that can operate between minimum and maximum pressures at a single flow rate. To operate near maximum pressure requires careful matching of the output pressure resistance with the pressure and flow capability of the hydrokinetic amplifier. If vapor pressure then drops, which can easily happen in an industrial environment placing other demands on the same vapor supply, the amplifier has insufficient motivating vapor to meet the output pressure resistance and stalls. This stops the outflow, dumps the inflow, and requires a restart. A sudden increase in liquid supply pressure can also cause a stall by supplying more liquid than the available vapor can accelerate through the output of the amplifier. Since fluctuations in liquid and vapor supply pressures are bound to occur, hydrokinetic amplifiers are usually designed to operate with less than optimum inputs, but this has the disadvantage of reducing the output performance, even when optimum inputs are available. These limitations make injectors and hydrokinetic amplifiers more difficult to match with output pressure resistances than centrifugal pumps, for example, which can vary the flow rate, as well as the pressure, of their outputs.

We have discovered a way of providing a hydrokinetic amplifier with a variable output flow rate, allowing it to better accommodate variations in inflow rates and in output pressure resistances. Our way of varying the outflow rate from a hydrokinetic amplifier surprisingly improves the efficiency of its diffuser so that hydrokinetic amplifiers provided with our invention can increase the product of the pressure and volume of their output. Our variable outflow rate can also be used for controlling the temperature of the output or the proportion of two flows combined into the output. This includes starting and stopping the flow of an additive material, such as a detergent or foaming agent, that can merge with the output flow, when desired by an operator. Our invention accomplishes improved efficiency and a variable output flow rate in a simple and inexpensive way that makes hydrokinetic amplifiers more versatile without adding significantly to their cost.

SUMMARY OF THE INVENTION

Our invention applies to an injector or hydrokinetic amplifier having a primary liquid input formed into a primary liquid jet surrounded by a motivating vapor that transfers vapor momentum to the primary liquid jet and accelerates the primary liquid jet through a minimum cross-sectional area upstream of a diffuser arranged beyond the minimum cross-sectional area. We admit a secondary fluid to merge with the primary liquid jet in a region beyond the minimum cross-sectional area, so that the secondary fluid flow and the primary liquid jet combine and proceed into the diffuser. We then can vary the flow rate of the output from the hydrokinetic amplifier by varying the fluid flow resistance of the load to which the output flow is delivered. Changing the fluid flow resistance of the load inversely varies both the rate of inflow of the secondary fluid and the rate of outflow from the diffuser to the load.

Liquid supplied to the hydrokinetic amplifier can be drawn from downstream of the diffuser and fed back to the primary liquid input. If the secondary fluid is a cooler liquid, this can be used to cool the primary liquid feedback in a counter current heat exchanger. The secondary fluid can also be a liquid warmer than the primary liquid jet; and if the secondary fluid has a different temperature from the primary jet, the proportions of the two flows can be controlled to adjust the temperature of the outflow. We have found that the product of pressure and volume (PV) of the combined primary and secondary flows can exceed the product of the pressure and volume of the primary liquid flow through the minimum cross-sectional area. We have also found that the additional flow through the secondary inlet varies inversely with the output pressure resistance to the combined primary and secondary flows. Moreover, we have discovered that the presence or absence of the secondary fluid in the outflow can be controlled by varying the fluid flow resistance of the load, to shut off the secondary fluid flow when the load resistance is high and to admit the secondary fluid flow as an additive to the primary flow by lowering the fluid flow resistance of the load.

DRAWINGS

Figure 1 is a partially cutaway, cross-sectional view of a preferred embodiment of a hydrokinetic amplifier having a secondary inlet according to the invention.

Figure 2 is a schematic diagram of preferred ways of operating a hydrokinetic amplifier according to the invention.

Figure 3 is a diagram of the performance of a hydrokinetic amplifier according to the invention compared with a prior art hydrokinetic amplifier.

FIG. 4 is a partially schematic view of a hydrokinetic amplifier provided with a secondary fluid inflow controlled by varying the fluid flow resistance of a load represented by a cleaning gun.

DETAILED DESCRIPTION

We vary the outflow rate of a hydrokinetic amplifier by admitting a secondary fluid to merge with the primary liquid flow through the hydrokinetic amplifier, and we have a preferred way of accomplishing this merger, as best shown in FIG. 1. A primary liquid input enters hydrokinetic amplifier 10 through a liquid input nozzle 11 to form a primary liquid jet directed into mixing chamber 12, which is partially cut away to shorten the view. Vapor that surrounds and accelerates the primary liquid jet enters hydrokinetic amplifier 10 via vapor nozzle 13 so that the vapor merges with the primary liquid jet and accelerates it through nozzle 15 and through minimum cross-sectional area 20, sometimes called "R area". The passageway through minimum cross-sectional area 20 can extend axially for a distance as illustrated or can be reduced axially to a single line within nozzle 15. At or beyond R area 20, passageway 15 terminates at end 14 to discharge and direct the primary liquid jet toward diffuser 16, having a diverging region 17 downstream of R area 20. Diffuser 16 also has a converging region 18 that surrounds and overlaps the terminated end 14 of passageway 15 and is spaced around passageway 15 to provide a secondary inlet.

Since the primary liquid jet departing from the terminated end 14 of nozzle passageway 15 has been accelerated to a high velocity by the surrounding vapor in mixing chamber 12 and nozzle 15, it establishes a low pressure region within secondary inlet 18. This draws in secondary fluid through opening 19 to flow along the conical path established by secondary inlet 18 to be guided in the same direction as the primary jet and to merge with the primary jet enroute to the diverging region 17 of diffuser 16. This directs the momentum of the secondary inflow to combine additively with the momentum of the primary jet so that the combined primary and secondary flows proceed into diffuser 16 where diverging region 17 converts their velocity to pressure.

We prefer that secondary inlet 18 be near the upstream end of diffuser 16 as illustrated and that passageway 15 terminate at end 14 before diverging from R area 20. Passageway 15 can also diverge from R area 20 before discharging into a secondary inlet located further downstream. The secondary inlet, besides surrounding the primary liquid jet, can also be formed as a plurality of openings into passageway 15; and this can be especially effective if passageway 15 is diverging from R area 20.

Previous suggestions have been made for inflowing of fluid into a hydrokinetic amplifier in a region above R area 20, and this has been done in several ways. Any fluid merging with the primary liquid jet above R area 20 must pass through R area 20, along with the primary liquid jet, and this limits the inflow rate of any secondary fluid. Also, above R area 20, the motivating vapor is accelerating and condensing in the primary liquid jet, so that merging a secondary fluid with the primary jet and its surrounding vapor may affect the vapor to liquid momentum transfer.

We have found that locating secondary inlet 18 beyond R area 20 has several advantages. The secondary inflow rate is not limited by the size of R area 20 and does not affect the acceleration of the primary liquid jet through R area 20. Also, the temperature of the secondary fluid inflow does not affect the condensation of the primary motivating vapor, which occurs primarily above R area 20.

When the secondary inflow is liquid, converging region 18 should be shaped so that the annular inflow region upstream of terminated end 14 converges for a nozzle effect accelerating the liquid inflow between the outside of passageway 15 and the inside of converging region 18. This speeds up the secondary liquid flow and aims it in the same direction as the primary jet so that the momentum of the secondary liquid is added to the momentum of the primary liquid jet. If the secondary inflow is a gas or vapor, then the annular inflow region between the outside of passageway 15 and the inside of conical region 18 should diverge or enlarge. This provides an expanding inflow region that accelerates a gas or vapor to combine its momentum with that of the primary liquid jet.

Assuming constant supplies of primary input of liquid and vapor, we have found that different output pressure resistances control the flow rate of a secondary fluid merged with the primary. For example, if the output pressure resistance is near the maximum output pressure produceable under particular operating conditions for a hydrokinetic amplifier 10, this pressure resistance produces a pressure balance in an upper region of diffuser 16 that restricts secondary inflow to little or nothing. As output pressure resistance drops, without change in the operating conditions for hydrokinetic amplifier 10, the pressure balance region within diffuser 16 moves downward toward its output end and accommodates an increasing inflow of secondary fluid. Although the output pressure of the flow generally reduces as secondary inflow increases, we have found that the product of the pressure and volume of an outflow including a secondary fluid is generally larger than the pressure and volume product of the primary liquid flow through minimum cross-sectional area 20.

The graph of FIG. 3 illustrates this. A prior art hydrokinetic amplifier having no secondary fluid inlet operates at a constant volume within range of pressures from points 30 to 31. The PV for a hydrokinetic amplifier 10 having secondary inlet 18

includes a variable volume up to a maximum possible flow at point 32 and pressures ranging slightly upward from point 31 to a peak 33, where a small inflow of secondary fluid occurs, and downward from peak 33 through a range of diminishing pressures and increasing flow rates.

The PV of a combined flow is normally no greater than the PV of a primary flow, as evidenced in a jet pump, for example, but we have observed higher PV's for combined flows from hydrokinetic amplifier 10 than the PV of the primary flow through minimum cross-sectional area 20. Although we are not certain of the reason for this, it appears that admitting secondary flow to the upper region of diffuser 16 makes the diffuser more efficient than if the primary flow alone is flowing through the diffuser. Increased diffuser efficiency may arise from lack of vapor passing into the diffuser, lack of cavitation in the diffuser, and other factors; but the surprising increase in PV output when secondary liquid is merged with the primary is well substantiated in our work.

One of the advantages of admitting a secondary liquid into inlet 18 is to allow hydrokinetic amplifier 10 to provide the maximum flow rate possible for a range of output pressure resistances. This makes amplifier 10 more versatile and more easily matched with output pressure resistances, which can also be varied during operation. In using amplifier 10 for powering a spray bar, for example, the total area of the openings of nozzles along the spray bar can be changed to vary the output pressure resistance; and throughout a range of such variation, amplifier 10 will provide a varying liquid flow rate up to maximum possible pressure. If the nozzle area is made larger, the delivery pressure reduces, but the flow rate increases. If the nozzle area is reduced, the delivery pressure increases, and the flow rate reduces. Previous hydrokinetic amplifiers with fixed flow rates could operate at varying output pressures, but could not increase the flow rate if the output pressure resistance dropped. The secondary inlet thus makes hydrokinetic amplifier 10 more versatile and more like a centrifugal pump whose output pressure and volume can both vary.

Changes in output flow rates, inversely to variation in fluid flow resistance of a load, also occur in our hydrokinetic amplifier without variation in flow rates or pressures of the primary liquid and vapor inputs. Thus, our variable flow rate hydrokinetic amplifier can be installed to operate with whatever liquid and vapor pressures are available in an industrial environment and can use these to produce a maximum outflow to a load, which can vary in its fluid flow resistance. This allows considerable versatility in varying the load, which can receive the maximum fluid flow for any resistance, while the hydrokinetic amplifier efficiently combines its primary inputs and compensates for load resistance by automatically varying the flow rate of the secondary input.

Besides using secondary liquid inflow to vary the output flow rate of hydrokinetic amplifier 10, a secondary liquid can also vary the temperature of the output flow. The primary liquid input to a hydrokinetic amplifier must be cool enough relative to the motivating vapor to condense the vapor in the primary liquid jet and thereby transfer the vapor momentum to the liquid, but there is no limitation on the temperature of a secondary liquid combined with the primary liquid jet at secondary inlet 18. A secondary liquid inflow cooler than the primary liquid jet flowing through R area 20 can reduce and regulate the temperature of the combined outflow. A primary flow of 93,3 °C (200 °F), for example, can drive an outflow at 65,6 °C (150 °F), if desired, by combining a suitable proportion of a secondary liquid inflow at a lower temperature. The outflow temperature can be controlled, as shown schematically in FIG. 2, by sensing the temperature of the outflow from diffuser 16 and using that to control a valve in the secondary fluid inlet.

The ability of the secondary inlet to accept different temperature liquids also allows it to accept secondary liquid or vapor hotter than the primary liquid jet. This can be used to recirculate hot washing water, for example, that could not be fed at high temperature into the primary liquid input. Cleaning chemicals, gases, and practically everything flowable can be directed into the secondary inlet to accommodate a wide variety of processes, such as evaporation, distillation, refrigeration, and others. Since a hydrokinetic amplifier can develop many times the output pressure of boiler vapor powering it, hydrokinetic amplifier 10 can be operated for feeding hot return water to a boiler via secondary inlet 18 while amplifier 10 is supplied with cool make-up water input to the primary inlet. Having two liquid inflows to hydrokinetic amplifier 10 allows control of proportional flow rates by varying the secondary inflow relative to the primary. The ability to increase the outflow rate by a large addition of secondary liquid allows amplifier 10 to pump cold water with only a minor increase in liquid output temperature.

Vapor as the secondary fluid inflow also has several important uses, including evaporation and distillation processes. The motivating vapor accelerating the primary liquid jet through R area 20 can be evaporated from a material such as maple sap or tomato slurry, and the evaporation pressure can be subatmospheric. Secondary inlet 18 can be used to entrain more of the evaporated vapor into diffuser 16. The entrained vapor can be accelerated toward the diffuser in a diverging inlet 18, to

add the vapor momentum to the liquid flow. This expands and cools the vapor somewhat, as the merged liquid and vapor proceed toward diverging region 17, where the velocity reduces and converts to pressure that condenses the vapor. This occurs beyond inlet 18 where it does not cause back pressure resistance to inflowing vapor. The ability of secondary inlet 18 to entrain additional vapor increases the capability of hydrokinetic amplifier 10 for evaporation. The additional vapor entrained at secondary inlet 18 increases the outflow temperature, but this can be used to advantage in evaporation processes by using multistage operation, preheaters, and other heat exchangers. Vapor condensed in hydrokinetic amplifier 10 can also be valuable as a distillate, and the distillation output can be increased in a similar way by admitting additional vapor through secondary inlet 18. This also applies to refrigeration and heat processes, where amplifier 10 can condense vapors such as ammonia flowing in refrigeration circuits.

The primary liquid input can be derived from the output of hydrokinetic amplifier 10, downstream of diffuser 16, as schematically shown in FIG. 2. If the secondary fluid input is liquid, it can cool the primary feedback liquid in a counter current heat exchanger as the feedback liquid heads for the primary inlet and the secondary liquid heads for secondary inlet 18. Since feeding back of pressurized output liquid to the primary liquid input speeds up the primary liquid jet and in turn increases the accelerated jet velocity and the output pressure, a feedback primary can give hydrokinetic amplifier 10 a very high pressure capability. This can increase the operating pressure range of amplifier 10 from very high pressures against very high output pressure resistances, down to much lower pressures and much higher flow rates augmented by a secondary liquid flow. Hydrokinetic amplifiers operated in a feedback mode have produced pressures as high as 20,7 MPA (3,000 psi), with no known upper limit, so that depending on the pressure strength of the piping and the maximum pressure resistance of the output, the operating range of amplifier 10 can be extended considerably by operating in the feedback mode as shown in FIG. 2.

The sensing of outflow temperature and the control of secondary input, as shown in FIG. 2, can occur for secondary flows of either liquid or vapor and does not require the feedback mode that is also illustrated in FIG. 2. Also, feedback and single pass operation can be used with a variety of controls for different liquids and vapors to achieve a wide range of effects, all taking advantage of secondary input.

The automatic effect of a varying load resistance on the inflow of the secondary fluid can be exploited in several ways, one of which is schematically illustrated in FIG. 4. A cleaning gun 25 having double barrels 26 and 27 and an operating trigger 28 can be connected by a line 29 to the output of hydrokinetic amplifier 10. This is supplied with a primary liquid and vapor in the usual way; and its secondary input is connected to a supply of an additive material 30, which can be a detergent or foaming agent, for example. A valve 31 in gun barrel 26 can be opened or closed by the operator to make gun 25 operate on either single barrel 27 or double barrels 26 and 27. In the single-barreled mode, delivering an output only through barrel 27, gun 25 provides a high resistance load to the output of hydrokinetic amplifier 10; and this automatically shuts off any inflow of additive material 30 into the secondary input. The outflow through single barrel 27 is then hot washing water.

If the operator opens valve 31, gun 25 delivers a flow through both barrels 26 and 27 and, in this double-barreled mode, presents a low fluid flow resistance load to hydrokinetic amplifier 10. This automatically causes an inflow of additive material 30 into the secondary input. At gun 25, the primary and secondary flows have become merged and are delivered from both barrels 26 and 27 to apply a detergent or foaming agent, for example. By opening and closing valve 31, the operator of gun 25 controls the flow of additive material, without involving any other moving parts. The outflow through both barrels 26 and 27 is at a lower pressure and higher flow rate than an outflow through single barrel 27. This can produce a flood of washing water and detergent, when valve 31 is open, and a vigorous, high-velocity rinse when valve 31 is closed.

The control of additive materials introduced to the outflow at the secondary input is not limited to washing guns and can be applied wherever a variable fluid flow resistance load is available for exerting the control. Since the secondary inflow automatically responds to varying load resistance, it can be turned on and off simply by changing the load.

Claims

1. A method for delivering fluid to a load by means of a hydrokinetic amplifier having a primary liquid input formed into a primary liquid jet surrounded by a motivating vapor that transfers vapor momentum to said primary liquid jet and accelerates said primary liquid jet through a minimum cross-sectional area upstream of a diffuser arranged beyond said minimum cross-sectional area, and connected to a load, a secondary inlet to permit a secondary fluid to merge with said primary liquid jet

in a region beyond said minimum cross- sectional area, so that said secondary fluid flow and said primary liquid jet combine and proceed into said diffuser, characterized by the steps of providing a supply of said secondary fluid to said secondary inlet (18) so that, when the fluid flow resistance of said load varies, the flow rate of said primary liquid jet through said minimum cross-sectional area (20) remains constant and both the rate of inflow of said secondary fluid and also the rate of outflow from said diffuser (16) vary inversely with changes in the fluid flow resistance of said load (25).

2. A method according to claim 1 wherein, when providing said secondary fluid, the pressure and volume product of the combined primary and secondary flows in said diffuser (16) exceeds the pressure and volume product of said primary liquid jet through said minimum cross-sectional area (20).

3. A method according to either one of the claims 1 and 2, wherein said secondary fluid is a vapor that accelerates said primary liquid jet into said diffuser (16) where velocity converts to pressure, and wherein a portion of said secondary fluid vapor condenses in said diffuser (16).

4. A method according to any one of the claims 1 to 3 comprising the further step of drawing liquid for said primary liquid input from downstream of said diffuser (16).

5. A method according to claims 1 and 2 comprising the further steps of drawing liquid for said primary liquid input from downstream of said diffuser (16) and of using secondary fluid being supplied to said secondary inlet (18) for cooling said primary liquid input before merging said secondary fluid with said primary liquid jet.

6. A method according to any one of the claims 1 to 5 comprising the further step of selectively controlling the fluid flow resistance of said load (25).

7. A method according to claim 6 wherein said step of providing said supply of secondary fluid includes arranging said secondary fluid to add a material (30) to said primary liquid jet, and said selectively controlling step includes (a) admitting said material (30) to said load by operating said load at a flow resistance sufficiently low to allow said secondary fluid to flow, and/or (b) excluding said material (30) from said load by operating said load at a flow resistance sufficiently high to stop said secondary fluid flow whereby said primary liquid jet continues.

8. A method according to claim 7 wherein said load comprises a double-barreled gun (25) and said selectively controlling step includes allowing fluid flow through only a single barrel (27) of said gun (25) to accomplish said high fluid flow resistance, and allowing fluid flow through both barrels (26, 27) of said gun (25) to accomplish said low fluid flow resistance.

9. A method according to any one of the claims 1 to 8 comprising the further steps of sensing the output temperature from said diffuser (16) and controlling said secondary fluid flow in response to the sensed temperature.

10. A method according to any one of the claims 1, 2 and 4 to 9, wherein said secondary fluid is a liquid having a higher temperature than said primary liquid jet.

11. A method according to any one of the claims 1 to 10 comprising the further step of varying said fluid flow resistance of said load without varying the inflow rate of said motivating vapor.

12. A method according to any one of the claims 1 to 10 comprising the further step of varying said fluid flow resistance of said load without varying the rate of flow of said primary liquid input.

13. A system for delivering a supply of fluid to a load, said system including a hydrokinetic amplifier having a primary liquid input formed into a primary liquid jet surrounded by a motivating vapor that transfers vapor momentum to said primary liquid jet and accelerates said primary liquid jet through a minimum cross-sectional area, and a diffuser positioned downstream of said minimum cross-sectional area and connected to the load, characterized by a secondary fluid inlet (18) arranged in said hydrokinetic amplifier beyond said minimum cross-sectional area (20) and upstream of the diffuser (16) to merge a secondary fluid with said primary liquid jet in said diffuser (16) and a secondary fluid supply connected to said secondary fluid inlet (18), said secondary supply being responsive to variations in the resistance to fluid flow from said diffuser (16) so that, when the fluid flow resistance of said load (25) varies, the supply of fluid to said secon-

dary inlet (18) and the outflow rate from said diffuser (16) to said load (25) vary inversely with said fluid flow resistance of said load (25), and so that the inflow rates of said primary liquid jet and said motivating vapor and the flow rate of said primary liquid jet through said minimum cross-sectional area (20) do not vary with said load resistance.

14. A fluid delivery system according to claim 13, wherein said primary liquid input is drawn from downstream of said diffuser (16).

15. A fluid delivery system according to any one of claim 13 to 14, including a heat exchanger in which said primary liquid input is cooled by said secondary fluid enroute to said secondary fluid inlet (18).

16. A fluid delivery system according to any one of claims 13 to 15, further comprising a mechanism for selectively controlling the fluid flow resistance of said load (25).

17. A fluid delivery system according to claim 16, wherein said mechanism for selectively controlling the fluid flow resistance of said load is a double-barreled gun (25), fluid being allowed to flow through both barrels of said gun (26, 27) to accomplish a low fluid flow resistance, and fluid being allowed to flow through only one barrel (27) to accomplish a high fluid flow resistance.

18. A fluid delivery system according to any one of claims 13 to 17, wherein said secondary fluid is a liquid containing an additive (30), the rate of inflow of said additive (30) into said secondary fluid inlet (18) being controlled by varying said fluid flow resistance.

19. A fluid delivery system according to any one of claims 13 to 18 including a sensor for the temperature of the output from said diffuser (16) and a control valve responsive to said sensor for controlling inflow into said secondary inlet (18).

20. A hydrokinetic amplifier used in a system according to claims 13 to 19 having a primary liquid input formed into a primary liquid jet surrounded by a motivating vapor that transfers vapor momentum to said primary liquid jet and accelerates said primary liquid jet through a minimum cross-sectional area upstream of a diffuser arranged beyond said minimum cross-sectional area, characterized by

a) a secondary liquid inlet arranged between said minimum cross-sectional area (20) and said diffuser (16) to merge a secondary liquid with said primary liquid jet in said diffuser (16),

b) said primary liquid input being drawn from downstream of said diffuser (16); and

c) said secondary liquid enroute to said secondary liquid inlet (18) being arranged to cool said primary liquid input.

Patentansprüche

1. Verfahren zum Zuführen einer Flüssigkeit an eine Zuladung durch einen hydrokinetischen Verstärker, enthaltend:

eine erste Flüssigkeitseinspeisung, die zu einem ersten Flüssigkeitsstrahl ausgebildet ist, der von einem Antriebsdampf umgeben ist, der die Bewegungsenergie des Dampfes an den ersten Flüssigkeitsstrahl überträgt und den ersten Flüssigkeitsstrahl durch einen minimalen Querschnittsbereich stromaufwärtig eines Diffusors, der hinter dem minimalen Querschnittsbereich angeordnet ist, beschleunigt und mit einer Zuladung in Verbindung steht;

einen zweiten Eingang, um zuzulassen, daß sich eine zweite Flüssigkeit mit dem ersten Flüssigkeitsstrahl in einem Bereich hinter dem minimalen Querschnittsbereich vermischt, so daß sich die zweite Flüssigkeitsströmung und der erste Flüssigkeitsstrahl vermischen und weiter in den Diffusor strömen,

gekennzeichnet durch die folgenden Schritte:

Zulieferung der zweiten Flüssigkeit an den zweiten Eingang (18) derart, daß wenn sich der Flüssigkeitsströmungswiderstand der Zuladung verändert, die Strömungsrate des ersten Flüssigkeitsstrahls durch den minimalen Querschnittsbereich (20) konstant bleibt und sowohl die Einströmungsrate der zweiten Flüssigkeit als auch die Ausströmungsrate vom Diffusor (16) in umgekehrtem Verhätnis zu Änderungen des Flüssigkeitsströmungswiderstandes der Zuladung (25) variieren.

2. Verfahren nach Anspruch 1, bei dem beim Zuleiten der zweiten Flüssigkeit das Produkt aus Druck und Volumen der kombinierten ersten und zweiten Strömungen in dem Diffusor (16) das Produkt aus Druck und Volumen des ersten Flüssigkeitsstrahls durch den minimalen Querschnittsbereich (20) übersteigen.

3. Verfahren nach Anspruch 1 oder 2, wobei die zweite Flüssigkeit ein Dampf ist, der den ersten Flüssigkeitsstrahl in den Diffusor (16) beschleunigt, wo Geschwindigkeit in Druck umgewandelt wird, und wobei ein Teil des Damp-

fes der zweiten Flüssigkeit in dem Diffusor (16) kondensiert.

4. Verfahren nach einem der Ansprüche 1 bis 3, enthaltend den weiteren Schritt des Abziehens von Flüssigkeit für die erste Flüssigkeitseinspeisung stromabwärtig des Diffusors (16).

5. Verfahren nach Anspruch 1 oder 2, enthaltend die weiteren Schritte des Abziehens von Flüssigkeit für die erste Flüssigkeitseinspeisung stromabwärtig des Diffusors (16) und Verwendung der zweiten Flüssigkeit, die an den zweiten Eingang (18) geliefert wird, zum Kühlen der ersten Flüssigkeitseinspeisung vor dem Vermischen der zweiten Flüssigkeit mit dem ersten Flüssigkeitsstrahl.

6. Verfahren nach einem der Ansprüche 1 bis 5, enthaltend die Schritte des wahlweisen Steuern des Flüssigkeitsströmungswiderstandes der Zuladung (25).

7. Verfahren nach Anspruch 6, wobei der Schritt des Erzeugens der Zulieferung der zweiten Flüssigkeit das Einrichten der zweiten Flüssigkeit beinhaltet, um ein Material (30) dem ersten Flüssigkeitsstrahl beizufügen, und wobei der wahlweise Steuerungsschritt (a) das Zuführen des Materials (30) an die Zuladung enthält durch Betreiben der Zuladung bei einem Strömungswiderstand, der niedrig genug ist, um eine zweite Flüssigkeit strömen zu lassen, und/oder (b) das Ausschließen des Materials (30) von der Zuladung durch das Betreiben der Zuladung bei einem strömungswiderstand, der hoch genug ist, um die zweite Flüssigkeitsströmung zu stoppen, wodurch der erste Flüssigkeitsstrahl nicht unterbrochen wird.

8. Verfahren nach Anspruch 7, wobei die Zuladung eine doppelläufige Kanone (25) enthält und wobei der wahlweise Steuerungsschritt es zuläßt, daß die Flüssigkeitsströmung durch nur einen einzigen Lauf (27) der Kanone (25) stattfindet, um diesen hohen Flüssigkeitsströmungswiderstand zu erzielen und daß die Flüssigkeitsströmung durch beide Läufe (26, 27) der Kanone (25), den niedrigen Flüssigkeitsströmungswiderstand einrichtet.

9. Verfahren nach einem der Ansprüche 1 bis 8, enthaltend die weiteren Schritte des Abtastens der Auslaßtemperatur von dem Diffusor (16), und das Steuern der zweiten Flüssigkeitsströmung in Reaktion auf die abgetastete Temperatur.

10. Verfahren nach einem der Ansprüche 1, 2 und 4 bis 9, wobei die zweite Flüssigkeit eine höhere Temperatur hat als der erste Flüssigkeitsstrahl.

11. Verfahren nach einem der Ansprüche 1 bis 10, enthaltend den weiteren Schritt des Variierens des Flüssigkeitsströmungswiderstandes der Ladung ohne die Einströmungsrate des Antriebsdampfes zu ändern.

12. Verfahren nach einem der Ansprüche 1 bis 10, enthaltend den weiteren Schritt des Variierens des Flüssigkeitsströmungswiderstandes der Zuladung, ohne die Ströumgsrate der ersten Flüssigkeitseinspeisung zu ändern.

13. System zum Liefern einer Flüssigkeit an eine Zuladung, wobei das System einen hydrokinetischen Verstärker enthält, der eine erste Flüssigkeitseinspeisung aufweist, die in einem ersten Flüssigkeitsstrahl ausgebildet ist, die von einem Antriebsdampf umgeben ist, der die Bewegungsenergie des Dampfes an den ersten Flüssigkeitsstrahl überträgt, und den ersten Flüssigkeitsstrahl durch einen minimalen Querschnittsbereich beschleunigt, und das einen Diffusor aufweist, der stromabwärtig des minimalen Querschnittsbereichs angeordnet ist und mit der Zuladung verbunden ist, gekennzeichnet duch einen zweiten Flüssigkeitseingang (18), der in dem hydrokinetischen Verstärker hinter dem minimalen Querschnittsbereich (20) und stromaufwärtig des Diffusors (16) angeordnet ist, um eine zweite Flüssigkeit mit dem ersten Flüssigkeitsstrahl in dem Diffusor (16) zu vermischen, und durch eine zweite Flüssigkeitszulieferung, die mit dem zweiten Flüssigkeitseingang (18) verbunden ist, wobei die zweite Zulieferung auf Änderungen des Widerstandes der Flüssigkeitsströmung des Diffusors (16) derart reagiert, daß wenn der Flüssigkeitsströmungswiderstand der Zuladung (25) sich ändert, die Flüssigkeitszulieferung an den zweiten Eingang (18) und die Ausspeisungsmenge vom Diffusor (16) an die Zuladung (25) sich umgekehrt mit dem Flüssigkeitsströmungswiderstand der Zuladung (25) ändert, und so daß die Einströmungsraten des ersten Flüssigkeitsstrahls und des Antriebsdampfes und die Einströmungsrate des ersten Flüssigkeitsstrahls durch den minimalen Querschnittsbereich (20) sich nicht zusmmen mit dem Zuladungswiderstand ändern.

14. Flüssigkeitszuliefersystem nach Anspruch 13, wobei die erste Flüssigkeitseinspeisung stromabwärtig des Diffusors (16) abgezogen wird.

15. Flüssigkeitszuliefersystem nach einem der Ansprüche 13 bis 14, enthaltend einen Wärmetauscher bei dem die erste Flüssigkeitseinspeisung durch die zweite Flüssigkeit auf dem Weg zum zweiten Flüssigkeitsausgang (18) abgekühlt wird.

16. Flüssigkeitszuliefersystem nach einem der Ansprüche 13 bis 15, weiterhin enthaltend einen Mechanismus zum wahlweisen Steuern des Flüssigkeitsströmungswiderstandes der Zuladung (25).

17. Flüssigkeitszuliefersystem nach Anspruch 16, wobei der Mechanismus zum wahlweisen Steuern des Flüssigkeitsströmungswiderstandes der Zuladung eine doppelläufige kanone (25) ist, wobei die Flüssigkeit durch beide Läufe der Kanone (26, 27) kann, um einen niedrigen Flüssigkeitsströmungswiderstand zu erzielen und wobei die Flüssigkeit auch durch nur einen Lauf (27) fließen kann, um einen hohen Flüssigkeitsströmungswiderstand zu erzielen.

18. Flüssigkeitszuliefersystem nach einem der Ansprüche 13 bis 17, wobei die zweite Flüssigkeit einen Zusatzstoff (30) enthalt, wobei die Einspeisungsmenge des Zusatzstoffes (30) in den zweiten Flüssigkeitseingang (18) durch das Variieren des Flüssigkeitsströmungswiderstandes gesteuert wird.

19. Flüssigkeitszuliefersystem nach einem der Ansprüche 13 bis 18, enthalten einen Sensor für die Temperatur der Ausspeisung aus dem Diffusor (16), und enthaltend ein Steuerventil, das auf den Sensor zum Steuern der Einspeisung in den zweiten Eingang (18) reagiert.

20. Hydrokinetischer Verstärker, der in einem System nach Anspruch 13 bis 19 verwendet wird, der einen ersten Flüssigkeitseingang aufweist, der in dem ersten Flüssigkeitsstrahl ausgebildet ist, der von einem Antriebsdampf umgeben ist, der die Bewegungsenergie des Dampfes an den ersten Flüssigkeitsstrahl überträgt und den ersten Flüssigkeitsstrahl durch einen minimalen Querschnittsbereich stromaufwärtig eines Diffusors beschleunigt, der hinter dem minimalen Querschnittsbereich angeordnet ist, gekennzeichnet dadurch, daß

(a) ein zweiter Flüssigkeitseingang zwischen dem minimalen Querschnittsbereich (20) und dem Diffusor (16) angeordnet ist, um eine zweite Flüssigkeit mit dem ersten Flüssigkeitsstrahl in dem Diffusor (16) zu vermischen,

b) die erste Flüssigkeitseinspeisung stromabwärtig des Diffusors (16) abgezogen wird; und

c) die zweite Flüssigkeit auf dem Weg zu dem zweiten Flüssigkeitseingang (18) zum Abkühlen der ersten Flüssigkeitseinspeisung angeordnet ist.

Revendications

1. Procédé de distribution d'un fluide à une charge à l'aide d'un amplificateur hydrocinétique ayant une entrée de liquide principale, formant un jet principal de liquide entouré par une vapeur de motivation qui transfère l'énergie cinétique de la vapeur au jet principal de liquide et accélère le jet principal de liquide dans une zone de section minimale qui est en amont d'un diffuseur placé audelà de la zone de section minimale et qui est connectée à une charge, une entrée secondaire destinée à permettre à un fluide secondaire de se mélanger au jet principal de liquide dans une région qui se trouve au-delà de la zone de section minimale, si bien que le courant secondaire de fluide et le jet principal de liquide se combinent et progressent dans le diffuseur, caractérisé par des étapes de transmission d'un fluide secondaire à l'entrée secondaire (18) de manière que, lorsque la résistance opposée par la charge à la circulation du fluide varie, le débit du jet principal de liquide dans la zone de section minimale (20) reste constant et le débit du courant d'entrée de fluide secondaire et aussi le débit du courant de sortie du diffuseur (16) varient inversement avec les variations de la résistance opposée à la circulation du fluide par la charge (25).

2. Procédé selon la revendication 1, dans lequel, lors de la transmission du fluide secondaire, le produit de la pression et du volume des courants principal et secondaire combinés dans le diffuseur (16) dépasse le produit de la pression et du volume du jet principal de liquide dans la zone de section minimale (20).

3. Procédé selon l'une des revendications 1 et 2, dans lequel le fluide secondaire est une vapeur qui accélère le jet principal de liquide vers le diffuseur (16) dans lequel la vitesse se transforme en pression, et dans lequel une partie de la vapeur du fluide secondaire se condense dans le diffuseur (16).

4. Procédé selon l'une quelconque des revendications 1 à 3, comprenant l'étape suivante d'aspiration de liquide destinée à l'entrée principale de liquide, depuis l'aval du diffuseur

(16).

5. Procédé selon les revendications 1 et 2, comprenant les étapes suivantes d'aspiration du liquide de l'entrée principale de liquide depuis l'aval du diffuseur (16), et d'utilisation du fluide secondaire transmis à l'entrée secondaire (18) pour le refroidissement du liquide principal introduit avant le mélange du fluide secondaire au jet principal de liquide.

6. Procédé selon l'une quelconque des revendications 1 à 5, comprenant l'étape supplémentaire de réglage sélectif de la résistance opposée par la charge (25) à la circulation du fluide.

7. Procédé selon la revendication 6, dans lequel l'étape de transmission d'un fluide secondaire comprend la disposition du fluide secondaire afin qu'un matériau (30) soit ajouté au jet principal de liquide, et l'étape de réglage sélectif comprend (a) l'admission du matériau (30) dans la charge par commande de la charge à une résistance de circulation suffisamment faible pour que le fluide secondaire puisse circuler, et/ou (b) l'exclusion du matériau (30) de la charge par commande de la charge à une résistance de circulation suffisamment élevée pour que le courant de fluide secondaire soit interrompu alors que le jet principal de liquide se poursuit.

8. Procédé selon la revendication 7, dans lequel la charge comprend un pistolet (25) à deux corps, et l'étape de réglage sélectif comprend la circulation du fluide dans un seul corps (27) du pistolet (25) afin que la résistance élevée opposée à la circulation du fluide soit obtenue, et la circulation du fluide dans les deux corps (26, 27) du pistolet (25) afin que la faible résistance opposée à la circulation du fluide soit obtenue.

9. Procédé selon l'une quelconque des revendications 1 à 8, comprenant les étapes supplémentaires de détection de la température de sortie du diffuseur (16) et de réglage du débit de fluide secondaire en fonction de la température détectée.

10. Procédé selon l'une quelconque des revendications 1, 2 et 4 à 9, dans lequel le fluide secondaire est un liquide ayant une température supérieure à celle du jet principal de liquide.

11. Procédé selon l'une quelconque des revendications 1 à 10, comprenant l'étape supplémentaire de variation de la résistance opposée à la circulation du fluide par la charge sans variation du débit d'entrée de vapeur de motivation.

12. Procédé selon l'une quelconque des revendications 1 à 10, comprenant l'étape supplémentaire de variation de la résistance opposée à la circulation du fluide par la charge sans variation du débit de circulation du liquide principal à l'entrée.

13. Installation de distribution d'un fluide à une charge, l'installation comprenant un amplificateur hydrocinétique ayant une entrée principale de liquide formant un jet principal de liquide entouré par une vapeur de motivation qui transfère l'énergie cinétique de la vapeur au jet principal de liquide et accélère le jet principal de liquide vers une zone de section minimale, et un diffuseur placé en aval de la zone de section minimale est raccordé à la charge, caractérisée par une entrée (18) de fluide secondaire placée dans l'amplificateur hydrocinétique au-delà de la zone de section minimale (20) et en amont du diffuseur (16) afin qu'un fluide secondaire soit mélangé au jet principal de liquide dans le diffuseur (16), et une alimentation en fluide secondaire raccordée à l'entrée (18) de fluide secondaire, l'alimentation en fluide secondaire étant sensible aux variations de la résistance opposée à la circulation du fluide par le diffuseur (16) afin que, lorsque la résistance opposée à la circulation du fluide par la charge (25) varie, la transmission du fluide à l'entrée secondaire (18) et le débit de sortie du diffuseur (16) vers la charge (25) varient inversement avec la résistance opposée par la charge (25) à la circulation du fluide, et afin que les débits d'entrée du jet principal de liquide et de la vapeur de motivation et le débit du jet principal de liquide dans la zone (20) de section minimale ne varient pas avec la résistance de la charge.

14. Installation de distribution de fluide selon la revendication 13, dans lequel le liquide principal est transmis depuis l'aval du diffuseur (16).

15. Installation de distribution de fluide selon l'une des revendications 13 et 14, comprenant un échangeur de chaleur dans lequel le liquide principal transmis est refroidi par le fluide secondaire dans son trajet vers l'entrée (18) de fluide secondaire.

16. Installation de distribution de fluide selon l'une quelconque des revendications 13 à 15, comprenant en outre un mécanisme de réglage sélectif de la résistance opposée par la charge

(25) à la circulation du fluide.

17. Installation de distribution de fluide selon la revendication 16, dans laquelle le mécanisme de réglage sélectif de la résistance opposée par la charge à la circulation du fluide est un pistolet (25) à deux corps, le fluide pouvant circuler dans les deux corps du pistolet (26, 27) afin qu'il crée une faible résistance opposée à l'écoulement du fluide, le fluide pouvant circuler dans un seul corps (27) afin qu'une résistance élevée soit opposée à l'écoulement du fluide.

18. Installation de distribution de fluide selon l'une quelconque des revendications 13 à 17, dans laquelle le fluide secondaire est un liquide qui contient un adjuvant (30), le débit d'entrée d'adjuvant (30) à l'entrée (18) de fluide secondaire étant réglé par variation de la résistance opposée à l'écoulement du fluide.

19. Installation de distribution de fluide selon l'une quelconque des revendications 13 à 18, comprenant un capteur de la température du courant de sortie du diffuseur (16) et une soupape de réglage commandée par le capteur et destinée à régler le débit à l'entrée secondaire (18).

20. Amplificateur hydrocinétique utilisé dans une installation selon l'une des revendications 13 à 19 ayant une entrée principale de liquide formant un jet principal de liquide entouré par un vapeur de motivation qui transfère l'énergie cinétique de la vapeur au jet principal de liquide et accélère le jet principal de liquide dans une zone de section minimale qui se trouve en amont d'un diffuseur placé au-delà de la zone de section minimale, caractérisé par :

a) une entrée de liquide secondaire placée entre la zone de section minimale (20) et le diffuseur (16) et destinée à mélanger un liquide secondaire au jet principal de liquide dans le diffuseur (16),

b) une entrée principale de liquide retiré d'un emplacement qui se trouve en aval du diffuseur (16), et

c) le liquide secondaire dirigé vers l'entrée (18) de liquide secondaire est destiné à refroidir le liquide principal introduit.

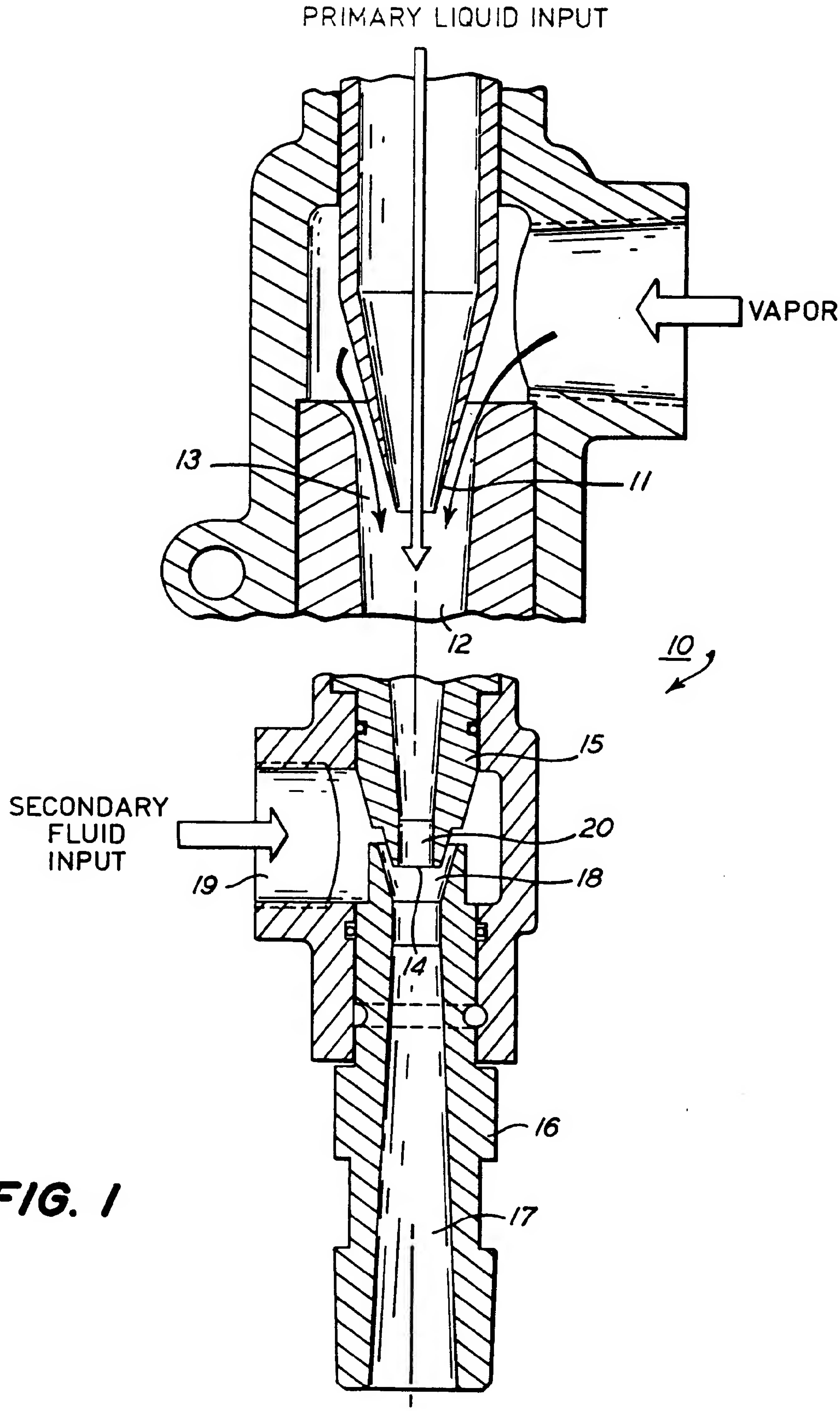
PRIMARY LIQUID INPUT
VAPOR
13
11
12
10
15
SECONDARY FLUID INPUT
20
19
18
14
16
17

FIG. 1

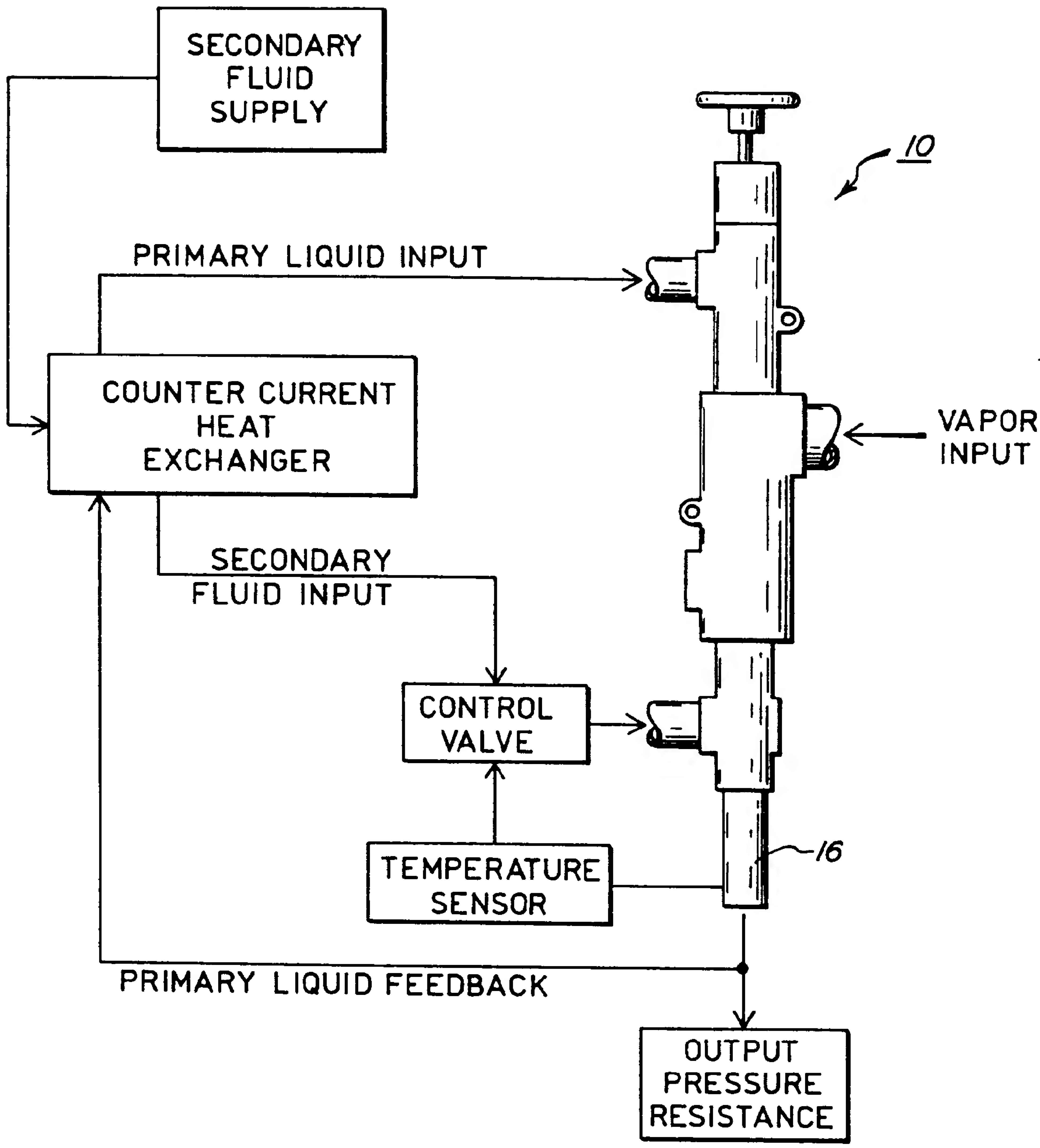
SECONDARY
FLUID
SUPPLY
10
PRIMARY LIQUID INPUT
COUNTER CURRENT
HEAT
EXCHANGER
VAPOR
INPUT
SECONDARY
FLUID INPUT
CONTROL
VALVE
TEMPERATURE
SENSOR
16
PRIMARY LIQUID FEEDBACK
OUTPUT
PRESSURE
RESISTANCE

FIG. 2

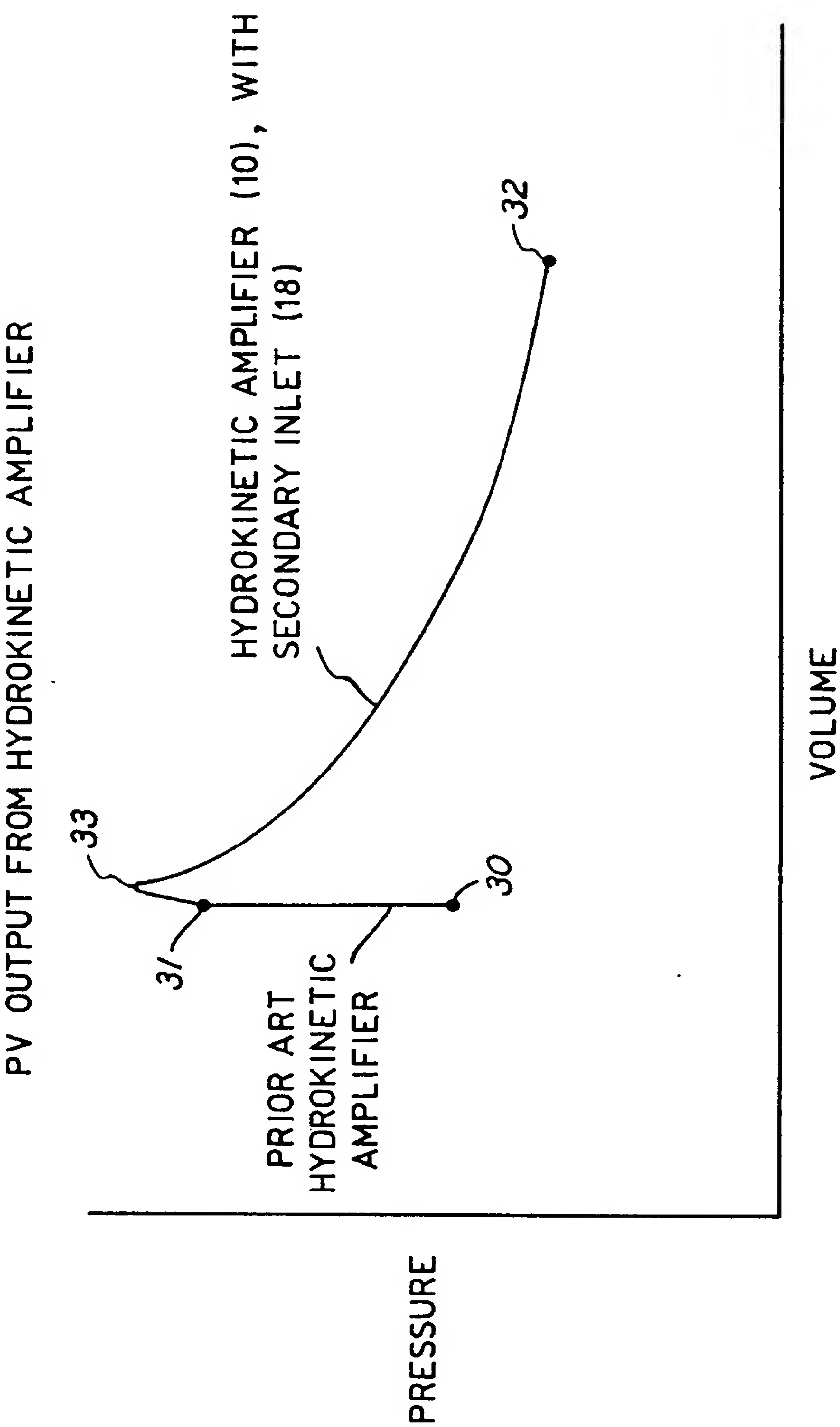
PV OUTPUT FROM HYDROKINETIC AMPLIFIER
HYDROKINETIC AMPLIFIER (10), WITH SECONDARY INLET (18)
PRIOR ART HYDROKINETIC AMPLIFIER
33
31
30
32
PRESSURE
VOLUME

FIG. 3

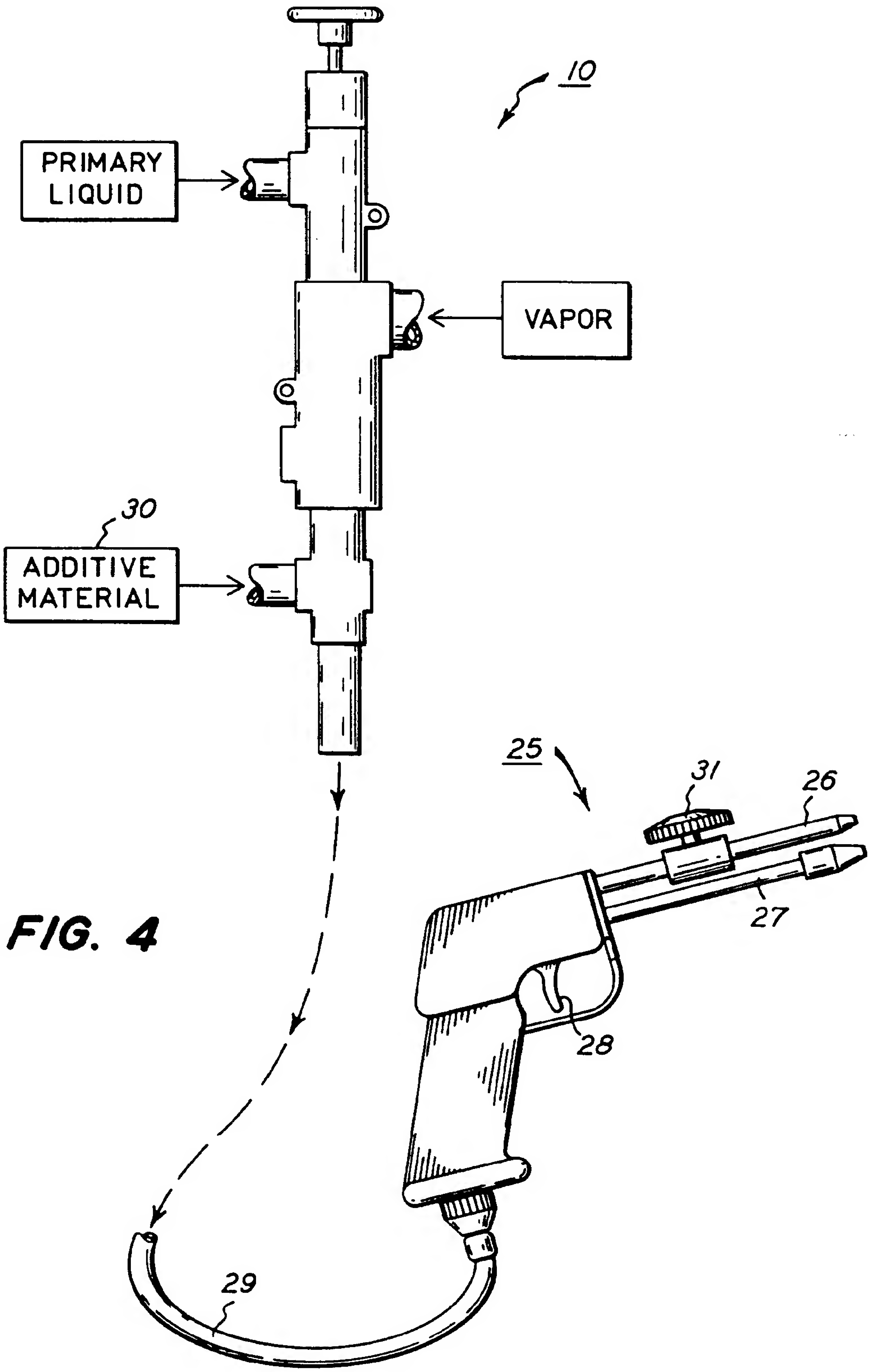
10
PRIMARY LIQUID
VAPOR
30
ADDITIVE MATERIAL
25
31
26
27
28
29

FIG. 4